ABSTRACTS OF THE PROCEEDINGS

OF THE

CHEMICAL SOCIETY.

No. 2. Session 1884-85.

February 5, 1885.—Dr. W. H. Perkin, F.R.S., President, in the Chair.

Messrs. J. B. Ballard, Frank Broughton, Rev. Dr. Eley, C. C. Hutchinson, Herbert Jackson and C. E. Hutchinson were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Edward Greenhill Amphlett, M.A., Woodside, Clewer, Windsor; Robert Gordon Blaine, B.E., Ridley Road, Forest Gate, E.; Frederick Mark Davies, 3, Glenmohr Terrace, Blackheath; Ernest Howard Farmer, 135, Dulwich Road, S.E.; Charles Watson, 5, Paradise Row, Stockton-on-Tees; Alfred Henry Knight, 321, Upper Parliament Street, Liverpool; Joseph Marshall Stocks, Edenfield, Bury, Lancashire.

The following were elected Fellows of the Society :—Messrs. William Lane Clark, John Norman Collie, Augustus E. Dixon, George Embrey, Arthur George Green, George G. Henderson, George Selkirk Jones, Walter Frederick Parkhurst, Franz Rindskoff, Harold White, Henry B. Whitehead, Alfred C. Wilson, William Albert Wrenn, Alfred C. Young.

A Lecture was then delivered—

9. "On Chemical Changes in their relation to Micro-Organisms." By Professor Frankland, D.C.L., LL.D., F.R.S.

A plant being defined as an organism performing synthetical functions, or one in which these functions are greatly predominant; an animal as an organism performing analytical functions, or one in which these functions greatly predominate : the micro-organisms were classed by the lecturer among animals. Their life essentially depends upon the taking asunder of more or less complex compounds, resolving them into simpler compounds at the expense of potential energy.

As micro-organisms are commonly termed "ferments," and their

analytical operations "fermentations," it is necessary to sharply distinguish between organised ferments and certain bodies which bring about analogous chemical changes, but which are not only not organised, but exist in solution. These latter, or "soluble ferments," as they are commonly termed, are said to act by contact: they produce certain chemical changes in the fermentescible substances without themselves furnishing from their own substance any of the products of change; the effects they produce are essentially analytical, consisting in the assimilation of water and the splitting up of the fermentescible substance into two or more new molecules, and may be brought about by purely chemical means. They differ only, or chiefly, from the organised ferments in that they are unorganised and do not increase in amount during their action upon fermentescible substances, of which a very large, although limited, quantity may undergo transformation by the action of a very minute quantity of the ferment. A list of changes brought about by unorganised ferments was given.

In that portion of the animal kingdom with which we are best acquainted, oxidation is the essential condition of life: it is the kind of action by which the animal changes actual into potential energy. The changes effected by micro-organisms are essentially of the same character as those brought about by the higher orders of animals: that is to say, they are all changes by which potential becomes actual energy. With one or two exceptions, the chemical changes effected by micro-organisms—unlike those produced by soluble ferments—cannot be brought about by other means. The observations of Hatton and others have shown that micro-organisms retain their vitality in presence of a variety of substances which rapidly prove fatal to higher animals; the unexpected fatal effects of spongy iron would seem to promise, however, that there are substances fatal to bacterial life which have no toxic effect on more highly organised animals. It has not yet been shown that any degree of cold, however intense, is fatal; animation may be suspended, but it is restored when the temperature rises. With regard to heat, the lowest fatal temperature recorded is 40° C., but many species can withstand much higher temperatures. Chloroform and compressed air are said to arrest their action, but to have no influence in preventing the changes brought about by unorganised ferments. The position of micro-organisms in nature is only just beginning to be appreciated; their study both from chemical and biological points of view is, however, of the highest importance to the welfare of mankind, and leads the inquirer right into those functions of life which are still shrouded in obscurity.

In the course of the lecture the best known micro-organisms and the chemical reactions due to them were passed in brief review.

Prof. FRANKLAND also referred to the following results of an experiment made in the month of June, in which fresh urine was allowed to stand for 25 days in a clean glass vessel.

	Residue left on evaporation and drying at 100° C.	Organic carbon.	Nitrogen as urea and other organic matter.	Ammonia.	Microscopical observations.
Fresh urine	4817·0	943·81	1080·27	142·40	No bacilli.
,, ,, after 1 day..	—	940·46	1095·05	136·65	,,
,, ,, ,, 3 days.	—	928·76	1106·70	136·50	,,
,, ,, ,, 5 ,, .	—	882·66	983·26	288·55	Sparse bacilli.
,, ,, ,, 7 ,, .	—	739·82	900·80	338·60	
,, ,, ,, 9 ,, .	—	682·99	784·93	485·12	Numerous bacilli.
,, ,, ,, 11 ,, .	—	621·02	744·64	534·80	Very numerous bacilli.
,, ,, ,, 14 ,, .	—	559·22	481·49	870·62	Vast numbers of bacilli.
,, ,, ,, 16 ,, .	—	530·68	492·04	881·87	Mostly still.
,, ,, ,, 18 ,, .	—	487·01	355·25	990·78	,, ,,
,, ,, ,, 21 ,, .	—	466·43	278·22	1105·75	All dead or still.
,, ,, ,, 23 ,, .	—	451·43	347·45	1017·25	,, ,,
,, ,, ,, 25 ,, .	2718·0	460·78	283·90	1070·50	
After allowing for evaporation	2045·5	346·77	213·66	805·63	

The results of these observations and determinations which were made during the month of June show conclusively that, previously to the development of *Bacillus ureæ*, the chemical composition of the urine remained practically unchanged; but with the appearance of micro-organisms, a diminution of organic carbon and a transference of nitrogen from the organic to the ammonia column immediately began. As regards rapidity, this change marched *pari passu* with the density of population, and reached its maximum about the 12th day; for during the three days (11th to 14th) nearly 10 per cent. of carbon disappeared, whilst more than 85 per cent. of the organic nitrogen became ammonia. After the 14th day the rate of change became much slower, on the 18th day the bacilli were mostly either dead or motionless, whilst on and after the 23rd day no more moving bacilli were seen. Altogether the quantity of carbon converted into carbonic anhydride, after allowing for concentration of the liquid by evaporation, amounted to 597·04 parts per 100,000 of liquid, or 63·3 per cent. of the total quantity; whilst the quantity of organic nitrogen converted into ammonia was 546·19 parts per 100,000, or 50·6 per cent. of the whole. These proportions show that all the organic nitrogen contained in the urea was not converted into ammonia. It no doubt escaped as free nitrogen, in accordance with Frank Hatton's observation.

In the original urine the proportion of organic carbon to organic nitrogen was as 1 : 1·15, whilst, after the action of the bacilli, it was as 1 : 0·62.

Prof. BURDON SANDERSON said that the main difficulty met with in studying the effects of micro-organisms arose from the fact that it was always difficult and often impossible to distinguish between different organisms. Chemists might naturally turn to biologists for aid in the matter, but biologists must admit the existence of this difficulty. We are fully acquainted with the life history of only one pathogenic organism—the *Anthrax bacillus ;* of this, thanks to Koch, we know, however, a great deal. The method followed by biologists in studying pathogenic forms was, in the first instance, to prepare a pure cultivation of the organism, and then to obtain the proof that the organism produces its proper effect when transferred to a living animal. The morphological relations of bacteria with plants could not be questioned, but he thought it was really of little consequence for practical purposes whether ferment organisms were regarded as animals or plants ; what we want to know is, what are the conditions under which an organism is produced, and its life history. He was in the habit of calling them microphytes, as being a neutral term.

Prof. RAY LANKESTER was astonished at the definite way in which Prof. Frankland had classed the ferment organisms with animals. Naturalists were led to regard them as plants from examining their relations to other organisms. He agreed with Prof. Sanderson that "microphyte" was a good name for them, although not precisely for the same reason, but because it really meant a little plant. He stated that it was held hitherto that a micrococcus induced the ammonic change in urine, and not a bacillus as figured by the lecturer. For the purpose of chemical investigation, it was essential to have a pure cultivation. It was curious that the nitrifying organism had not been isolated ; its presence had only been inferred, and it had never been satisfactorily separated and identified, although inconclusive statements and observations purporting to inform us as to the form of that organism had been published.

Dr. BRUNTON said that it was highly probable that the symptoms occurring in certain diseases were due to poisons formed by the action of organisms and not directly to the organisms themselves. This was not improbably the case in cholera. Micro-organisms may even produce substances fatal to themselves, *e.g.*, phenyl compounds. This is also the case with higher organisms, the retention of the urine in man being often attended with fatal results. Although cholera was very probably due to the presence of low organisms, the symptoms were so very like those produced by certain poisons, that it was very difficult

to diagnose cases of poisoning by arsenic from cholera cases. The cholera poison was probably of an alkaloïdal character and related to the ptomaïnes. Pepsin converted albuminoïds into peptones, but it was important to note that Brieger had observed that sometimes an alkaloïd having an action similar to curare was formed during peptic digestion, and an alkaloïd having a similar action had been obtained from human urine. These facts rendered it probable that alkaloïds might be formed in the intestinal canal and absorbed into the general circulation.

Prof. M. FOSTER said that the question whether the micro-organisms in question were plants or animals was to him a matter of indifference compared to the question—what was the exact nature of the action by which the organism effected the chemical change? He desired to point out that in certain cases, as in the ammonic conversion of urea, the same change, in this case the conversion of urea into ammonium carbonate, was effected, on the one hand, by a micro-organism, a micrococcus or bacillus, and on the other hand by an unorganised ferment. His friend Mr. Sheridan Lea informed him that he had evidence of both these causes of ammonic conversion of urea. Now, was the action in both cases the same? The idea had naturally occurred that the organism produced its effect by producing an organised ferment. But all attempts to prove the production of such a secretion, so to speak, of a ferment had failed. If such a ferment were produced, it was destroyed or disappeared during its action, whereas ordinary unorganised ferments such as pepsin, &c., were not destroyed at all during their activity, or were destroyed very slowly. On the whole, the probability was that the micro-organism and the unorganised ferment produced the same result in different ways; ought not that *difference* to offer the key for solving the problem?

He further desired to remind the Fellows that actions similar to those of these micro-organisms were continually being carried on by the constituent elements of man and other macro-organisms, and would wish, in illustration, to call their attention to the act of secretion by a secreting cell, such as the pancreatic cell. We had evidence that certain constituents of pancreatic juice existed in the cell, not in the form in which they appear in the juice itself, but in an anterior more complex condition. Thus trypsin occurs in the pancreatic cell not as trypsin but as trypsinogen. Now this trypsinogen, and also probably other "mothers" of the constituent of the juice, exist in the protoplasm of the cell as *discrete granules, lodged in the meshes of the protoplasm, separated from the protoplasm by films of fluid.* Yet the protoplasm, stirred by some nervous impulse, is able to produce a change in these granules, so that they are discharged to form the

secretion. How does the protoplasm work upon these granules? Does it discharge something into the fluid of its meshes, which something acts upon the granule, or does it work upon the granule through the film of fluid surrounding the granule, by something which is a sort of "action at a distance." The action then in this case is very comparable to the action of the micro-organisms in question. It is for the chemists to throw light on the exact nature of the changes produced, and when this is done, we may hope to learn how the change is brought about, but not until this is done.

Mr. THISELTON DYER said that from the botanist's point of view he was struck with the universality of fermentative changes. Though they were so predominant a feature in the life of the lower plants, this was only an extreme manifestation of what, perhaps, all plants were capable of, if the conditions demanded it. Thus Pasteur, following up an experiment of Bérard's, found that a rhubarb leaf in an atmosphere of carbon dioxide yielded after 48 hours, though apparently unchanged, small quantities of alcohol. The breaking up of molecules of large thermic equivalent into those of less, supplies the energy needed for the continued life of the tissues, and is the *raison d'être* of the process.

But plants also set up fermentative changes external to themselves, as it were incidentally and without any obvious benefit. The investigation of Beyerinck on the production of gum by plants yielded most remarkable results. It is due to a disease which is highly contagious, and which is caused by a fungus (*Coryneum*). This produces a ferment which changes the cell-walls into gum. But what is most remarkable is that even after the disappearance of the fungus which initiated the changes, the cells of the host plant take on a morbid habit of growth, and themselves continue the production of the ferment and therefore of gum to their own hurt. The problem is here of the most complicated kind.

The series is ended by cases such as that of *Withania coagulans* (and many others are now known), where plants throw off, as bye-products of their metabolism, ferments as effective as rennet, without deriving any perceptible advantage from their possession. That plants use in working up their reserve-proteïds proteolytic ferments just as animals do, cannot be doubted. But even these they occasionally, as in the Papaw, produce in utter disproportion to their own possible requirements.

Mr. WARINGTON said with regard to the difference between animals and plants, he thought the fact had been somewhat overlooked that plants are able to obtain their nitrogen from such simple compounds as ammonia and nitrates, whereas animals appear to require to have the nitrogen presented to them in an albuminoïd form

As to the nature of the nitrifying organism, Müntz and Schlösing

claim to have isolated it and have described it. A friend who had microscopically examined his purest cultivations at Rothamsted, had been unable to find bacilli, but they appeared to contain a micrococcus. [Prof. LANKESTER, interposing, remarked that the growth sent to him by Mr. Warington consisted of bacilli, and nothing else.] In explanation, Mr. Warington said that in one of his earlier papers he had mentioned that white films appeared on some of his solutions. Prof. Lankester had examined these, but he had since found that the bacilli of which they consisted were incapable of nitrifying ammonia. Latterly he had followed Dr. Klein's method, and had introduced the infecting matter into the sterilised cultivation liquid by means of a capillary pipette, which was pushed through the cotton-wool plug closing the tube or flask; since he had done this, the films referred to had never been formed.

Dr. THUDICHUM agreed that the ammonic change was produced in urea by a micrococcus. The study of microphytes and of the chemical changes produced by them in the human body and in the bodies of animals was of the greatest importance. He questioned whether their action was always so specific, however, as was commonly supposed. He would also call attention to the fact that one micro-organism will kill another: thus, after plastering wine, in consequence of the removal of the tartrate, the microphyte which produces ropiness is crowded out by alcoholic forms.

Dr. STEVENSON called attention to the importance of obtaining more information as to the alkaloïdal bodies formed by the action of micro-organisms.

Prof. FRANKLAND replied that he did not mean absolutely to say that in his experiments the work was done by the *Bacillus ureæ*, but the diagram was a faithful representation of what he saw; he attributed the action to the particular organism, because it commenced when the organism appeared, and ceased when the bacilli became motionless. The necessity of studying the actions of pathogenic organisms had been prominently brought forward in the discussion. He thought there was a substantial difference between the class of chemical changes effected by plants on the one hand and by animals on the other; animals more particularly consumed as food those compounds in which much energy was stored up.

ADDITIONS TO THE LIBRARY.

I. Donations.

Chemical News. Vols. 15 and 16: from Sir H. E. Roscoe.

Photographic News: from Dr. Atkinson.

Nova Acta Academiæ Cæsareæ Leopoldino-Carolinæ Germanicæ Naturæ Curiosorum. Vols. 45 and 45: from the Academy.

Year Book of Pharmacy and Transactions of the British Pharmaceutical Conference, 1884: from the Conference.

Calendar of the Pharmaceutical Society, 1885: from the Society.

Salpetersäure-Goldnitrat und einige neue Derivate desselben, von P. Schottlander: from the Author (*Pamphlet*).

By Purchase.

Chemie der Kohlenstoffverbindungen: V. v. Richter. 4te Auflage, 1885.

Pyrochemische Untersuchungen: C. Langer and V. Meyer. 1885.

Das Sauerstoff-Bedürfniss des Organismus: P. Ehrlich. 1885.

La Pile électrique: A. Niandet. 1885.

Chimie appliquée à l'Art de l'Ingéneur: C. Leon Durand-Claye. 1885.

Titles of Papers of interest to Chemists recently read before Societies in the United Kingdom:—

(*a.*) "On the Origin of the Proteids of the Chyle and the Transference of Food Materials from the Intestine into the Lacteals." By E. A. Schäfer, F.R.S.

(*b.*) "Observations on the Chromatology of Actiniæ." By C. A. MacMunn, M.A., M.D.

(*c.*) "The Relation of Bacteria to Asiatic Cholera." By E. Klein, M.D., F.R.S. Royal Society of London: (*a* and *b*) January 22nd; (*c*) February 5th.

"On Condensation and Evaporation." By Prof. Tait. Royal Society of Edinburgh, February 2nd.

"Final Report bearing upon the Question of the Condition in which Carbon exists in Steel." By Sir Frederick Abel, C.B., D.C.L., F.R.S. Annual General Meeting of the Institution of Mechanical Engineers, January 30th.

"Note on Selenocarbamide or Selenium-urea;" and "Note on Schiff's Method for the Distinction of Aldehydes from Ketones." By Prof. Emerson Reynolds. Royal Dublin Society, January 19th.

At the next meeting of the Society on Thursday, February 19th, the following papers will be read:—

"On Ethylic Benzoylacetate and some of its Derivatives." Part II. By Dr. W. H. Perkin, Junr.

"On Toughened Filter Papers." By E. E. H. Francis.

"The Detection and Estimation of Iodine." By Ernest H. Cook.

"Note on Methylene Chlor-iodide." By Prof. J. Sakurai.

"A Quick Method for the Estimation of Phosphoric Acid in Fertilisers." By J. S. Wells.

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